EDES

SAFE FOOD IN ACP
A PROGRAMME FUNDED BY THE EU

HANDBOOK 1.1

TOPIC 1

Food Safety System

1

BASIC FOOD SAFETY CONCEPTS

COLEACP

The handbooks are tools designed for civil servants in charge of restructuring the food safety system, and for all operators involved in drawing up the food safety policy and organising official controls (qualified civil servants, heads of laboratories, heads of departments in official organisations, those in charge of official controls, trainers, technicians, researchers, experts or company executives). They aim to provide an overview of the main points of a specific subject. All of the topics addressed by EDES during the training sessions are covered in separate handbooks.

The handbooks have been designed and drawn up by the EDES Training Unit in cooperation with the Consortium members.

Ecole Nationale des Services Vétérinaires

fera The Food and Environment Research Agency

France Vétérinaire International

Ministère de l'Agriculture et de l'Agroalimentaire

Natural Resources Institute

anses French agency for food, environmental and occupational health safety

DTU Food National Food Institute

cirad

EDES is a European cooperation programme managed by COLEACP. COLEACP is an international network promoting sustainable horticultural trade. It is funded by the European Union and was implemented at the request of the ACP (African, Caribbean and Pacific) Group of States. EDES aims to promote food safety in African, Caribbean and Pacific countries. EDES operates in all sectors in response to a request filed at national level by any public or private stakeholder involved in the food safety process.

EDES

EDES c/o COLEACP
130, rue du Trône • B-1050 Brussels • Belgium
Tel : +32 (0)2 627 52 90 • Fax : +32 (0)2 627 52 99
Email : edes@coleacp.org
www.coleacp.org/edes

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Content

The texts in this handbook are taken from PIP Manual No. 1 -
PRINCIPLES OF HYGIENE AND FOOD SAFETY MANAGEMENT (COLEACP/PIP, Brussels, 2011).
PIP is an ACP-wide cooperation programme funded by the EDF and managed by COLEACP.

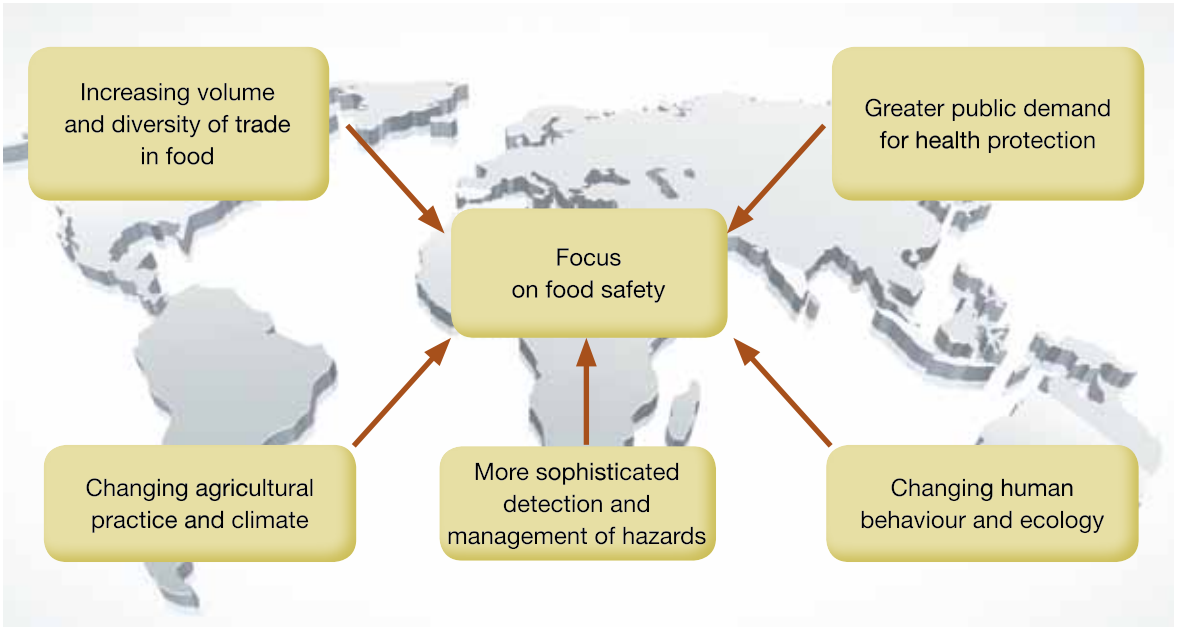
1. The importance of the problem

1.1 Introduction

Food-borne disease remains a real and formidable problem in both developed and developing countries, causing great human suffering and significant economic losses. Dangerous pathogens and contaminants in food are on the increase as travel and tourism grow. Up to one third of the population of developed countries may be affected by food-borne diseases each year, and the problem is likely to be even more widespread in developing countries, where food and water-borne diarrheal diseases kill an estimated 2.2 million people each year, most of them children[1]. In 2007 it was reported that in the United States, foodborne diseases result in 37.2 million illnesses, 228,744 hospitalizations, and 2,612 deaths annually.

In addition to food-borne diseases, chemical hazards in foods occasionally cause acute illnesses, and some food additives, residues of pesticides and veterinary drugs, and environmental contaminants may also pose risks of long-term adverse effects on public health.

Figure 1: Factors driving changes in food safety systems



Source: PIP Manual N°1, "Principles of hygiene and food safety management"

1 WHO Initiative to Estimate the Global Burden of Foodborne Diseases. First formal meeting of the Foodborne Disease Burden Epidemiology Reference Group (FERG). Geneva, 26–28 November 2007

2. The concept of food safety

Basic food safety concept

The basic food safety concept is that food will not harm the consumer so long as intended use guidelines are followed when it is prepared or eaten.

Conversely, food is potentially harmful whenever it has been exposed to hazardous agents and intended use guidelines have not been followed (ISO 22000, 2005)

Foods are generally considered safe, provided that care is taken during development, primary production, processing, storage, handling and preparation. Food safety involves all aspects from farm to fork. For many foods, the level of food safety generally accepted by the society reflects the history of their safe consumption by humans. In many cases the knowledge required to manage the risks associated with foods has been gained through their history of use. However, this general acceptance of historical safety does not necessarily mean that some traditional foods may not cause adverse health effects under some circumstances.

With respect to more recent technologies, genetically modified (GM) foods for example are not inherently less safe than their traditional counterparts (OECD 1993). However, due to lack of past experience with GM foods and concerns about novel technologies, these foods have been subjected to rigorous safety assessment procedures that are not generally applied to traditional foods.

Food consumption plays two roles in human development: nutrition and disease prevention. Foods provide not only protein, fats, vitamins, minerals and other constituents essential for growth, but also components necessary for prevention of certain diseases.

For proper growth and mental development, people must eat a balanced diet.

Some human illnesses can be traced to foods. The causes of these illnesses may be natural constituents of foods, such as contaminating pathogenic bacteria, or chemicals in minute amounts that have been added for other purposes, such as pesticides for insect control before harvest or food additives for enhancing food quality and safety.

Responsibility for food safety is shared by everyone involved with food from production to consumption, including growers, processors, regulators, distributors, retailers and consumers.

3. Related food safety concepts

There a number of words, terms or concepts one may come across during discussions on food safety. The list below is not exhaustive, concepts are constantly evolving but the most common are described. We start off with the concept of hazards and risks in our foods.

3.1 The concepts of 'hazard', 'risk' and 'crisis'

In order to meet food quality and safety requirements, agricultural businesses must identify all aspects of their activities that are decisive factors for the safety of their products. They must be able to **control all hazards at all stages** of product life cycle (development, production, storage, transport, marketing) in order to meet specifications (regulatory and market) and assure consumers that their food is safe.

The operators must therefore be able to **identify all hazards** (physical, biological or chemical) that can potentially contaminate their products at different stages of production.

They must also be able to **assess the level of each risk** (probability) according to their working conditions, procedures and practices. On the basis of these analyses, the appropriate control measures, adapted to the type and level of risk, can be adopted. The company must then make sure that these measures are effectively implemented, complied with and regularly reviewed.

Risk analysis at every stage of production and packaging is thus indispensable and must precede any preventive action.

It is important to understand the difference between the terms 'hazard' and 'risk':

Food safety hazard

A food safety hazard is an agent or condition that could potentially cause an adverse human health effect. Agents are either in or on food and can be biological, chemical, or physical. Furthermore, the condition of the food itself can also be hazardous.

Food safety hazards can also be found in or on animal feed and feed ingredients. Since these may be transferred to food through the consumption of animal products, they can also cause adverse human health effects.

Food safety risk

A food safety risk is the probability of an adverse health effect. The degree of risk is a combination of the probability and the severity of the effect (type of harm, number of people affected, etc.).

'Risk' refers to exposure to a hazard, in other words to consumption of a contaminated food (quantity and frequency of consumption).

Table 1: Examples of hazards that may occur in foods

Biological hazards	Chemical hazards	Physical hazards
Infectious bacteria Toxin-producing organisms Moulds Parasites Virus\es Prions Blood	Naturally occurring toxins Food additives Pesticide residues Veterinary drug residues Environmental contaminants Chemical contaminants from packaging Allergens	Metal, machine filings Glass Jewellery Stones Bone chips Brittle plastics

Adapted from PIP Manual N°1 "*Principles of hygiene and food safety management"*

There is no such thing as "ZERO RISK" therefore an analysis of risks is needed to determine what the hazards are and to assess their immediate, interim and long-term effects on human health.

The three main components of risk analysis have been defined by Codex (defined later) as follows:

- **Risk assessment:** A scientifically based process consisting of the following steps: i) hazard identification; ii) hazard characterization; iii) exposure assessment; and iv) risk characterization;
- **Risk management:** The process, distinct from risk assessment, of weighing policy alternatives in consultation with all interested parties, considering risk assessment and other factors relevant for the health protection of consumers and for the promotion of fair trade practices, and, if needed, selecting appropriate prevention and control options;
- **Risk communication:** The interactive exchange of information and opinions throughout the risk analysis process concerning risk, risk-related factors and risk perceptions, among risk assessors, risk managers, consumers, industry, the academic community and other interested parties, including the explanation of risk assessment findings and the basis of risk management decisions.

The analysis method must be one that has been tested and validated.

Some practical risk management alternatives contributing to food safety include:

- Establishment of regulatory limits
- Monitoring food products before and during harvest and processing
- Screening and testing products in commercial channels
- Developing decontamination procedures
- Diverting products to less risky uses

The Precautionary Principle

The precautionary principle states that: where there is evidence to indicate presence of an unacceptable risk to consumer safety, action shall be taken to minimise that risk and protect consumer health, even if the supporting scientific evidence required for a comprehensive risk assessment has yet to be gathered. Such actions or measures shall be temporary until such time that the scientific evidence is obtained and a risk assessment conducted.

This principle forms the foundation of food safety in EU legislation (EU Regulation 178/2002 Article 7), although not yet included in the Codex global standards.

It is also important to clarify the meaning of the term '**food crisis**'.

According to terminology accepted by experts, **a 'crisis'** is a situation in which a **real or hypothetical risk** can lead to **collective misgivings** throughout a population group. It is clear that a crisis can occur even if the risk never materialises.

The crisis occurs when a **malfunction** is measured or when a gap between reality and expected standards is either measured or suspected. This can occur, for example, when **results of an internal or external control** (including documentary controls) or **of analyses** reveal that insufficient mastery of a process has resulted in non-conformity with a standard (e.g. maximum residue levels (MRL) exceeded) or product contamination (e.g. traces of dioxin in eggs, avian flu virus detected, etc.).

A crisis is also a situation where organisations, private firms and competent authorities (ministries, inspection agents, laboratories, etc.) strive to cope with a situation considered as 'critical'. For a given period of time they find themselves in the forefront where, under **heavy external pressure and acute internal tensions,** they enter into conflict with one another, often under the media's watchful eyes!

Europe has gone through a series of 'crises', all with repercussions among the public, regardless of how serious the crises actually were. Over the past few years alone we can cite:

- 1997: **Numerous cases of BSE (mad cow disease)**
- 1999 : ***Listeria* – Illegal dioxin levels in chickens**
- 2001-2002: **Foot and Mouth disease, Genetically Modified Organisms, various meat origin frauds**
- 2003: **Sudan red dye**
- 2004: **Avian (bird) flu**
- 2006: **BTV - Catarrhal fever (blue tongue virus)**
- 2008: **Melamine-tainted milk powder**
- 2009 and 2010: **Hepatitis A – Dried tomatoes**
- 2011: ***E. coli* outbreak related to sprouting seeds**

3.1.1 CODEX

The Codex Alimentarius International is an international reference for food safety standards. Codex standards have become global reference points for consumers, food industries, national food agencies and the international food trade. It is therefore important to consider the role of the Codex Alimentarius in any discussion of food safety certification programmes.

The Codex Alimentarius Commission was created by FAO and WHO in 1963 to develop food standards, guidelines and related texts.

In 1969, The Codex Alimentarius Commission brought out the Recommended International Code of Practice-General Principles of Food Hygiene (GHP) which has undergone four revisions.

In 2005, the ISO (International Organization for Standardization) stepped in and brought out ISO 22000:2005 to harmonize on a global level, food safety management systems.

CODEX Food safety standards[2]

- Primary objective – food is safe and suitable for human consumption
- Ensure fair trade practices in the food trade
- Follow the food chain – farm to fork
- Take into account the wide diversity of activities and varying degrees of risk involved in food production
- Lay a firm foundation for ensuring food hygiene with each specific code of hygiene practice applicable to each sector
- Codex recommends a HACCP based approach (defined later) wherever possible to enhance food safety as desired

3.1.2 ISO 22000

The ISO 22000 food safety standard integrates the Codex Alimentarius Commission's seven principles of HACCP and dynamically combines them with Pre-requisite programmes (PRPs) necessary to control and reduce any food safety hazards. Since ISO 22000 is a generic food safety management standard, it can be used by any organization directly or indirectly involved in the food chain. ISO 22000 applies to all organizations in the food chain. Further, it is immaterial how complex the organization is or what size it is, and can help ensure the safety of its food products.

2 Rajendran, M. 2010. Concepts of food safety and quality management systems

3.2 Pre-requisite programmes (PRPs) and the concept of 'hygiene'

Pre-requisite programmes (PRPs)

Pre-requisite programmes (PRPs) *are the conditions that must be* established throughout the food chain and the activities and practices that must be performed in order to establish and maintain a hygienic environment.

PRPs must be suitable and be capable of producing safe end products and providing food that is safe for human consumption.

Many but not all potential food hazards can be controlled along the food chain through the application of good practices. PRPs are also referred to as good hygienic practices (GHP), good agricultural practices (GAP), good production practices, good manufacturing practices (GMP), good distribution practices, and good trading practices.

➤ **General principles of food hygiene:**
It is up to each actor in the food production and distribution chain to take all steps to make sure that products placed on the market are free of all risks to consumers' health.

(Source: Graffham, A., NRI UK)

Many of the hazards attributed to food originate in the **failure to respect hygiene rules at the place of production**. This can be in the field or on the packaging line, or during storage or transport. For this reason general rules of hygiene applicable to the food industry are also valid for primary production. As a large proportion of **fruit and vegetables is eaten raw**, hygiene is an essential requirement for the conformity of these products.

Simple or cross-contamination of fruit and vegetables, either before or after harvest, can have **several causes**. Growing areas, soil, inputs (manure), equipment and staff are all potential germ vectors. Each producer or firm should organise hygiene measures and practices that are adapted to the specific conditions of their production area, type of products, methods and techniques, and staff in order to monitor and control risks to food safety and promote the production of wholesome fruit and vegetables.

See the Codex website at http://www.codexalimentarius.net for examples of PRPs and access to all food safety publications.

3.3 The concept of 'hazard analysis and critical control point' (HACCP)

An important preventative approach and concept that may be applied at all stages in the production, processing and handling of food products involves the Hazard Analysis and Critical Control Point system (HACCP). The *Codex Alimentarius* recognises HACCP as the benchmark for identifying hazards and controlling risks in the food sector. In the agri-food sector, HACCP is considered to be the most efficient and is the most widely used. It is generally **mandatory by regulation** for all food-processing firms. For primary production, however, at present it is only **recommended** (in the framework of European Regulations).

Benefits of HACCP System

A HACCP study should identify **all currently conceivable hazards** including those which can realistically be predicted to occur. Applying HACCP principles should:

- Provide cost effective control for food borne hazards
- Focus technical resources into critical parts of the process
- Lead to reduced product losses
- Be complementary to other management systems
- Ensure compliances with legal requirements
- Be used as a management tool that provides a more structured approach to the control of identified hazards in comparison to traditional inspection and quality control procedures
- Move a company from a retrospective end product testing approach towards a preventive quality assurance approach
- Be a systematic approach covering all aspects of food safety from raw material to final product

Pre-requisite programmes described earlier support HACCP plans. HACCP plans use critical control points (CCPs) and critical limits to control (**not eliminate) food safety hazards, while PRPs do not.**

3.4 The concept of 'product'

'Product' is understood to mean the **result of production,** in other words a coherent sequence of operations (the term 'process' is discussed below).

(Source: © Olga Lyubkin - Fotolia.com)

In the broad sense of the term, products are all foods of plant or animal origin that a producer **places on the market.**

When we speak of a 'product' we are referring to products that have been harvested, possibly processed, and packaged.

Other foods are not considered to be 'products' in the strict sense of the term, even though they are marketed. This the case for products that have been picked or collected in natural conditions, such as mushrooms, berries, small fruits, aromatic herbs, edible insect larvae or gastropod snails, or even honey produced by colonies in the wild. This is also the case for food that has been fished or hunted.

Despite the fact that these foods were not produced under someone's responsibility, but were merely 'collected', **the person selling these foods nonetheless remains completely responsible** for ensuring that they do not harm consumers' health.

Conformity with health and safety standards **must be ascertained.**

Some types of food can be considered as **'high-risk foods'**. A majority of cases of food poisoning are in fact caused by:

- Eggs and egg-based products, which account for about one third of foodborne illness (FBI) outbreaks;
- Poultry, in particular chicken and minced chicken meat;
- Food eaten raw (fruit, vegetables, fish, meat or shellfish).

Each type of food product is associated with different types of risks due to their **nature** (origin, composition, sensitivity); **production mode**; **preservation mode; mode of preparation and consumption** (raw or cooked).

It is thus important for the producer to be fully aware of the **characteristics** of the products and processes in order to **evaluate the risks**.

Street foods

Segments of the population depend entirely on street foods, having no access to their own cooking facilities. The safety of street foods in particular is therefore a cause for concern, as they are often prepared and held under poor hygiene practices.

➤ Eggs and egg-based products

According to the US Department of Agriculture (USDA) about 2.3 million of the 50 billion eggs produced each year are infected with *Salmonella* (primarily *Salmonella* Enteritidis).

The main means of control is to respect the **cold chain** and to pay scrupulous attention to use-by dates.

➤ Poultry and poultry-based products

Chicken is often a *Salmonella* carrier. The mere presence of these bacteria does not pose any particular risk because chicken is almost always eaten cooked. However, *Salmonella* brought into the kitchen by this means can **contaminate other food items that are not cooked** (such as vegetables).

Food can be contaminated:

- either **directly**: if the chicken directly touches other food, in the refrigerator for example;
- or through **surfaces** that later come into contact with other food.

The bywords therefore are strict hygiene – from hatching to slaughter and cutting – and thorough cooking.

➤ Foods eaten raw or only slightly cooked

- **Fruit and vegetables,** even when eaten raw, should in principle not pose a high risk for consumers, apart from allergies that some people may have to exotic fruit which is often allergenic.

Eaten raw, they are rarely harmful and are even highly recommended by nutritionists (*'eat five portions of fruit and vegetables per day'*). Nonetheless they can pose **serious risks** for consumers due to the presence of:

- **pathogenic micro-organisms**, especially of faecal origin, through accidental contamination during production (e.g. tainted irrigation water), harvest (e.g. unwashed hands), transport (e.g. insufficiently disinfected containers), or packaging (e.g. insufficient hygiene);

- '**toxins**' (mycotoxins) caused by poor storage conditions and overlong preservation; chemical residues (nitrates, pesticides, biocides) or heavy metals which contaminate the food.

Prevention essentially means respecting Good Agricultural Practices and applying good hygiene measures during harvest and packaging. **Meat and fish** in principle should be no more risky than other foods, since they are generally only eaten after cooking, which eliminates most parasites and pathogenic bacteria.

Nevertheless, with changing preparation and consumption habits (the sushi fad, for instance), these foods become more risky with respect to **food poisoning**.

When eaten raw they pose a much higher risk than other products for the following reasons:

- Animals are **natural carriers of certain parasites** (such as *Anisakis*, which can reproduce or survive in the human intestine after being consumed in raw fish: herring, mackerel, tuna, salmon, etc., or *Ascaris,* found in the intestines of many animals).
- Animals are **naturally contaminated on the surface** (skin) by excrement and thus carry germs. Even washing after slaughter cannot totally eliminate these germs.
- Sale and distribution of meat and fish imply **cutting/slicing operations**, or mincing and mixing, all occasions where the food is liable to be contaminated by staff, equipment, work surfaces or the food products themselves.

Prevention does not require complicated measures: fish and meat must be cooked to 70°C (at least). Fish can be eaten raw after it has been deep frozen for a few days at -20°C.

➤ **Allergy-causing foods**

In addition to risks of biological or chemical contaminants, there is also the risk of allergy that the presence (even traces) of certain foods or food components (such as egg yolks, celery, groundnuts) can pose for sensitive consumers. The producer must be aware of the risk of cross-contamination between products.

3.5 The concept of respecting the 'cold chain'

(Source: C.C.F Technologies)

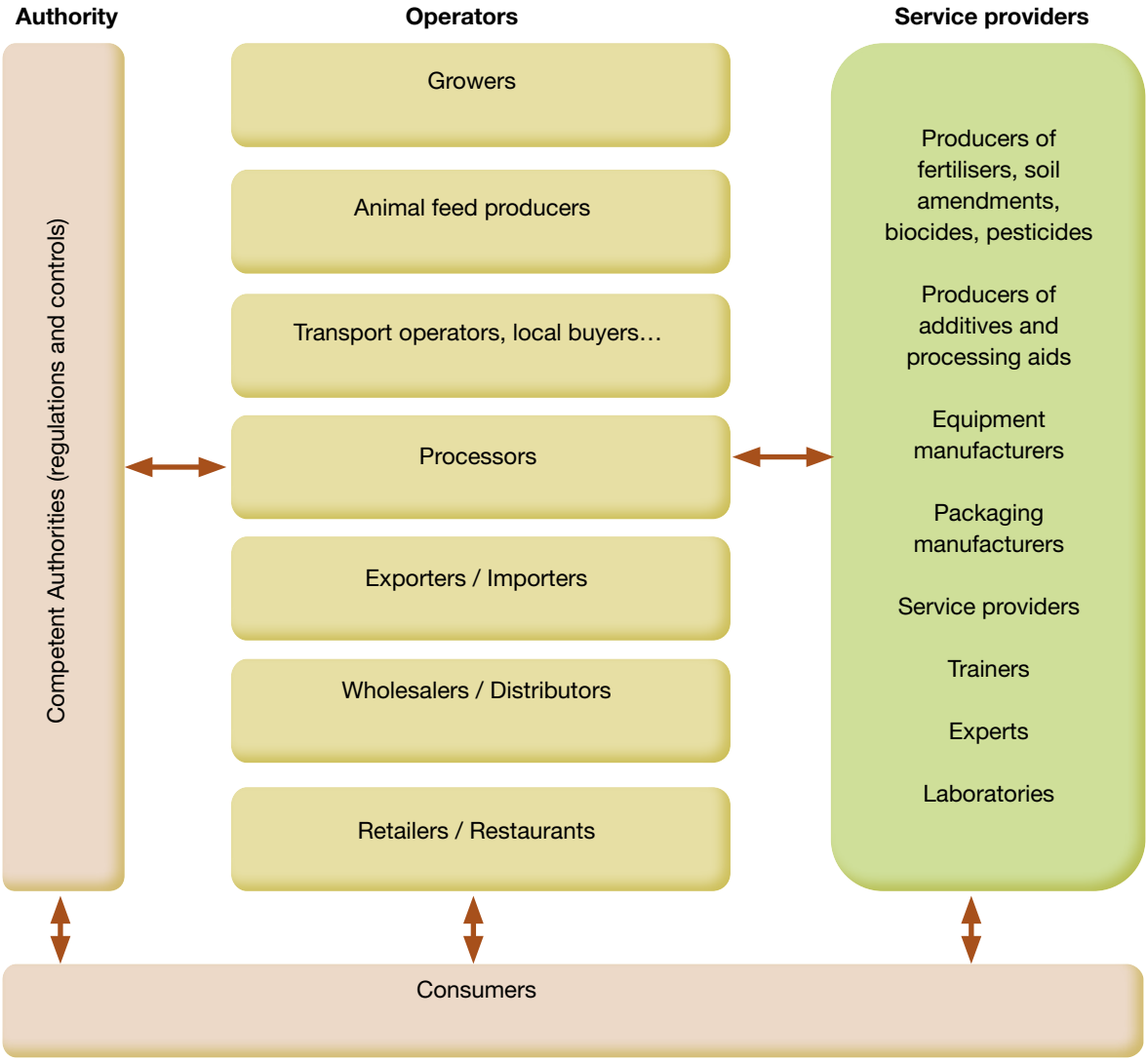
To ensure the stability of physiological properties of fresh produce, the **optimal temperature and relative humidity of storage must be known for each product.** If required, fruit and vegetables must be harvested, transported and preserved at low temperatures (examples: green beans, tomatoes, etc.).

Fruit and vegetables must be handled with care to avoid injuries that make the products more vulnerable to pathogens. Failure to keep food at the right **temperature and relative humidity** can lead to spoilage and favour the development of pathogenic micro-organisms. The 'cold chain' **must** be respected.

3.6 The 'food chain' concept

Ensuring food safety must be a goal for all 'actors' along the **food chain** (another term for 'actors' is ***stakeholders***). *Just like a real chain, it is the 'weakest link' that determines the sturdiness of the whole system. The image is totally appropriate.*

An approach that focuses on the food chain to manage food safety and quality recognises that **all actors are responsible** for providing food that is safe, healthy and nutritious (FAO, 2010). The diagram below shows the parties involved in the food chain, and indicates the information flow:



Source: PIP Manual N°1, "Principles of hygiene and food safety management"

3.7 The concept of 'farm-to-fork'

(Source: teacher.beecoop.co.uk)

The objective of reduced risk can be achieved most effectively by the principle of prevention throughout the production, processing and marketing chain. To achieve maximum consumer protection it is essential that safety and quality be built into food products from production through to consumption.

This calls for a comprehensive and integrated ***farm-to-fork*** approach. The concept is that the producer, trader, processor, transporter, vendor and consumer all play a vital role in ensuring food safety and quality.

3.8 The concept of 'process'

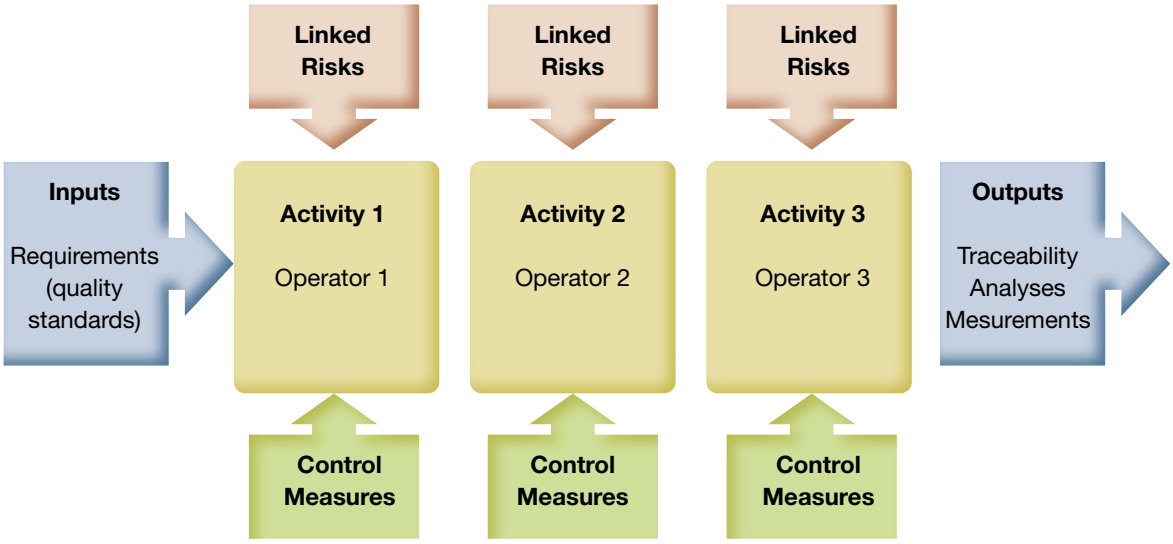
A process can be described as a **chain of activities** that transforms 'input data' into 'output data'. According to ISO 9000 a process is a sequence of activities accomplished by different players in order to meet an internal or external need by making a product or service available to the customer. Process inputs can be a product, raw material or information.

> *'Placing a food product on the market'* is a **complex process** that requires the **involvement of several operators**

It is also one that requires a combination of **different skills** to attain an objective. A company's production process approach can be depicted as described below.

An objective and meticulous analysis of the process is important in order to identify:

- The *sequence of operations* (steps in the process), and to be able to distinguish between **operations that can directly influence the safety** of a product and those that are production 'process supports' (which, although important, do not have a direct or indirect influence). This analysis is a crucial step in organising hygiene measures, drawing up a HACCP plan and choosing the appropriate control measures. As each company has its own organisation mode, this type of analysis **cannot be transposed** from one to another.
- The *risks linked to each operation* (e.g.: crop management, harvest, transport, cleaning, etc.).
- The *responsibilities of each entity involved* and the skills required for each.
- The *inspection measures* (records necessary for traceability) and *control measures* that are relevant for each step in the process.



Source: PIP Manual N°1, "Principles of hygiene and food safety management"

Describing the overall process, in other words the chronological sequence of key steps and the operations carried out, **is something that must be validated on site.** The analysis consists of examining the whole process and methodically calculating the relative importance of each relevant parameter. This involves visits to the various process sites, interviews with staff and customers, measurements and analyses, all of which are used in a fact-finding approach.

The **complete analysis of the process will yield a picture of how a company operates**. It will be used to ascertain its results in terms of quality and conformity of its products, and also to foresee the risks associated with its organisational and functional mode.

3.9 The concept of 'system'

System

….a group of interacting, interrelated, or interdependent elements forming a complex whole and designed to work as a coherent entity.

Food safety must be **conceived as an 'organised system'** with the aim of meeting the regulatory objective of producing safe and suitable food

Food safety must be **conceived as an 'organised system'** with the aim of meeting a regulatory objective (producing safe and suitable food) and, if relevant, other contractual objectives (complying with one or more private certification schemes). The industry refers to this as a **Food Safety Management System (FSMS).**

All food safety management systems must be grounded in the elements that the ISO 22000:2005 standard deems as essential to guarantee the safety of food at every link in the food chain:

- interactive communication between all players in the food chain,
- systemic approach (system-based management),
- prerequisite programmes,
- HACCP principles.

As for any system, a company's FSMS must be designed and prepared. It is then built, managed, evaluated regularly, adjusted and improved (principle of ongoing improvement).

Although a management system can be certified if the customer requires this or if it represents a competitive advantage, **certification in itself does not guarantee** that food safety objectives have been met. The company's objective should be quality and conformity of the products, not mere *certification.*

In reality this system often covers management of *food and phytosanitary* quality. It deals with regulatory requirements concerning quarantine organisms in relation to phytosanitary certification for exports.

A food safety management system is designed to:

- Meet the food safety policy and achieve the measurable objectives related to the policy
- Meet performance of "effectiveness" (extent to which planned activities are realized and planned results achieved) and "efficiency" (relationship between the results achieved and the resources needed)
- Apply proven management principles aimed at continually improving performance over the long term by focusing on customers while addressing the needs of all other stakeholders

Food safety management systems or programmes are designed to limit exposure to foodborne risks.

3.10 The concept of 'traceability'

Traceability of a product means the ability to identify:

- all stages of its manufacture
- the origin of its components and their suppliers
- where the product and its components have been stored
- checks and tests on the product and its components
- equipment used in manufacturing or handling
- customers who bought the product (this does not apply to retail though)
- authenticity of components

Traceability aims to meet **two different yet complementary objectives:**

1. It must be able to **locate** the product in space and time. *Tracking* means the ability to physically follow a product consignment. This is especially useful in a food crisis, to locate products that have to be withdrawn or recalled.

2. Traceability, however, also means being able to *trace* information on the **history and composition of the product**: origin of the seed or plants, crop management practices, inputs used in production, plant protection treatments, processing methods and steps, and so on.

Setting up a 'traceability system' is a *sine qua non* for food safety and is also mandatory by regulation.

Traceability

Traceability is the ability to identify and trace the history, location, and application of products and materials. A traceability system records and follows the trail as products and materials come from suppliers and are processed and distributed as end-products.

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EDES is funded by the European Union

Printed on FSC-certified paper
with environmentally friendly
solvent-free inks.
Publication date: September 2012

FSC
www.fsc.org
MIX
Paper from responsible sources
FSC® C012447

Design : www.inextremis.be